Hydro-Québec's Future Generating and Transmission System

Hydro-Québec's Development Plan
1988-1990, Horizon 1997

Documents in this folder outline Hydro-Québec's development strategy for its future generating and transmission system. They are provided as a supplement to *Hydro-Québec's Development Plan 1988-1990, Horizon 1997*, and include:

1. The brochure *Long-Term System Expansion Plan*.

2. Data sheets outlining Hydro-Québec's development strategy and the accompanying environmental concerns.

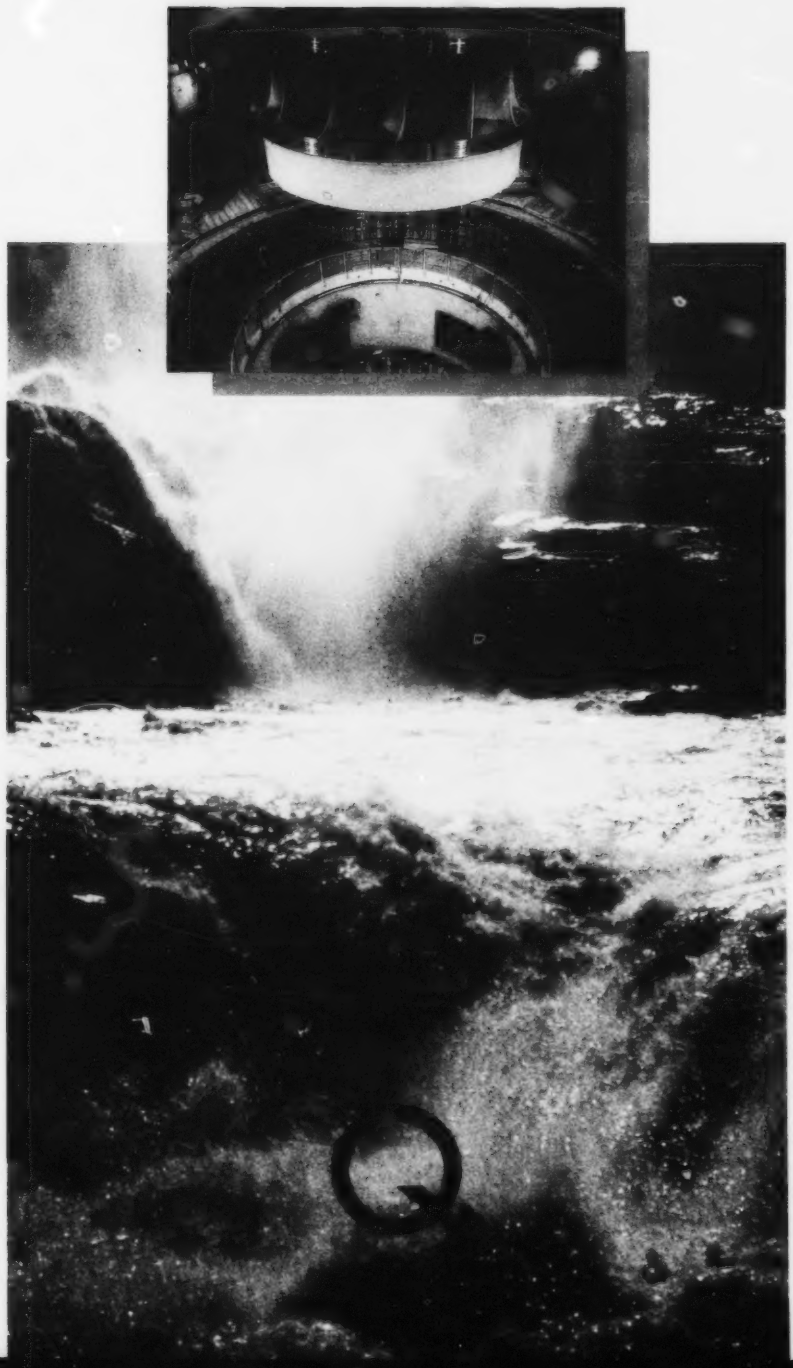
3. The brochure *Project Procedures and Land Use Management*.

4. Maps.

The cover photographs show the Broadback Falls in the James Bay region and a Hydro-Québec transmission line.

Long-Term System Expansion Plan

Hydro-Québec's Future Generating and Transmission System



March 1988

The cover photographs show the Broadback Falls in the James Bay region and a turbine being lowered into its shaft at La Grande 4 generating station.

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FOREWORD

The decision to build new generating and transmission facilities is linked to the growth in the demand for electricity in Québec and the development of export sales. The choice of facilities and sites is based on a set of economic, technical, technological and social factors.

This brochure is designed to complement the *Hydro-Québec Development Plan 1988-1990, Horizon 1997*. It shows the current status of the generating and transmission facilities, reviews the generating stations and transmission lines planned up to 2006, and presents the possibilities for the longer-term development of the system.

Because the development plan must be revised as the context changes, Hydro-Québec intends to make its construction program as flexible as possible. It also intends to review its choices for construction and land use according to technological developments that it will be promoting in the future.

It should be noted that this brochure covers power transmission lines but does not cover Hydro-Québec's sub-transmission and distribution system.

1. HYDRO-QUÉBEC'S INTENTIONS

The unharnessed rivers of Québec represent a potential of 40,000 megawatts. Today, 18,000 megawatts of this potential is considered more economical than any other type of power generation, whether oil-fired, coal-fired or nuclear.

Hydro-Québec intends to develop this potential in order to meet Québec's electricity requirements. Over the long term, this will mean the harnessing of six rivers and the construction of eight transmission lines and about 15 substations.

Because hydroelectricity has an economic advantage over other forms of generation, it can be exported at a profit. Hydro-Québec proposes to reschedule the construction of some of its facilities if advantageous contracts can be signed with neighboring systems. At the end of these contracts, the facilities already built can be used to meet the demand within Québec.

The *Hydro-Québec Development Plan 1988-1990, Horizon 1997* estimates the cost of this construction program at $3.7 billion (1988 dollars) from 1988 to 1990 and $17.6 billion from 1991 to 1997. Sales to neighboring systems would generate the necessary revenue and stimulate economic activity in Québec by hastening the creation of jobs for power system development and economic spin-offs in the manufacturing and service sectors.

2. THE PRESENT HYDRO-QUÉBEC SYSTEM

Hydro-Québec's generating and transmission system now has 80 generating stations with a total installed capacity of more than 24,500 megawatts, with access to an additional 5,000 megawatts from Churchill Falls. It also has about thirty 735-kilovolt substations and ten 735-kilovolt transmission lines covering almost 10,000 kilometres. Another transmission line, the Radisson-Nicolet-Des Cantons 450-kilovolt direct-current line, and two more generating stations at Manic 5 and La Grande 2 are now under construction.

The system began along the St. Lawrence River, where most of the favorable sites for generating stations have now been developed: St-Maurice, Beauharnois, Carillon, etc. Once the potential near urban centres was harnessed, Hydro-Québec had to look farther and farther north, to the North Shore region (Bersimis, Manicouagan, Outardes) and Churchill Falls, and then, in the early 1970s, to the James Bay region.

As these developments became more and more remote, Hydro-Québec used increasingly higher voltage levels for its transmission system. From 315 kilovolts when Bersimis was built, the system went to 735 kilovolts with the construction of the Manicouagan complex.

THE PRESENT TRANSMISSION SYSTEM

Line	Link			Commissioning
1st line	Manic-Outardes Complex	< - - >	Lévis-Montréal	1965
2nd line	Manic-Outardes Complex	< - - >	Lévis-Montréal	1966-1969
3rd line	Churchill-Manic-Outardes	< - - >	Québec City-Montréal	1970-1971
4th line	Churchill-Manic-Outardes	< - - >	Québec City-Montréal	1972-1975
5th line	Churchill-Manic-Outardes	< - - >	Lévis	1973
6th line	La Grande Complex	< - - >	Montréal	1979
7th line	La Grande Complex	< - - >	Montréal	1980
8th line	La Grande Complex	< - - >	Montréal	1981-1982
9th line	La Grande Complex	< - - >	Saguenay-Québec City	1983
10th line	La Grande Complex	< - - >	Saguenay	1984
11th line	La Grande Complex (LG 2 A)	< - - >	Radisson-Nicolet-Des Cantons	1990 *

* Currently under construction, this direct-current line will be the sixth line from James Bay.

Subtransmission and Distribution

The transmission system is extended by a number of lower-voltage lines and substations which bring the electricity to Hydro-Québec's customers: the subtransmission system (18,000 kilometres) and the distribution system (96,000 kilometres). These systems will not be discussed in this brochure.

3. THE FUTURE SYSTEM

Hydro-Québec's proposed construction program is designed for maximum flexibility in case of changes in the energy market. It is a general framework within which projects can be accelerated, postponed or modified if the domestic and export markets fail to evolve as forecast or if constraints on land use are encountered.

Moreover, the program is based on choices and assumptions defined by today's technology, which could be modified if significant technological breakthroughs occur in the coming decades.

Application of the program is linked to the results of technical, economic and environmental studies as well as government authorization.

3.1 New generating stations

Québec has vast water resources, especially in the North where many large rivers constitute an immense potential. Any new generating stations will therefore be built in the northwestern part of the province, where all the major complexes are already located.

The 18,000-megawatt potential will be developed in the following sequence: Phase II of the La Grande Complex (La Grande 1, Laforge 1 and Brisay), development of the Sainte-Marguerite, the Grande Baleine and Ashuapmushuan Complexes, Laforge 2 and Eastmain 1 generating stations, and the Nottaway-Broadback-Rupert (NBR) and La Romaine Complexes. The following page shows the commissioning dates for these projects, based on an average 2.7% growth in Québec demand over the long term and an initial export target of 3,500 megawatts by the year 2000. These are the hypotheses used to determine the target scenario in the *Hydro-Québec Development Plan 1988-1990, Horizon 1997.*

3.2 New transmission lines

To transmit the power generated by these new stations, Hydro-Québec must build two more lines connecting the North Shore to the load centres, and six more lines in Northwestern Québec. They will be 735-kilovolt alternating-current lines and will require about 15 new substations. No more than four of the eight new lines will cross the St. Lawrence: one west of Montréal, one east of Québec City and two between Montréal and Québec City.

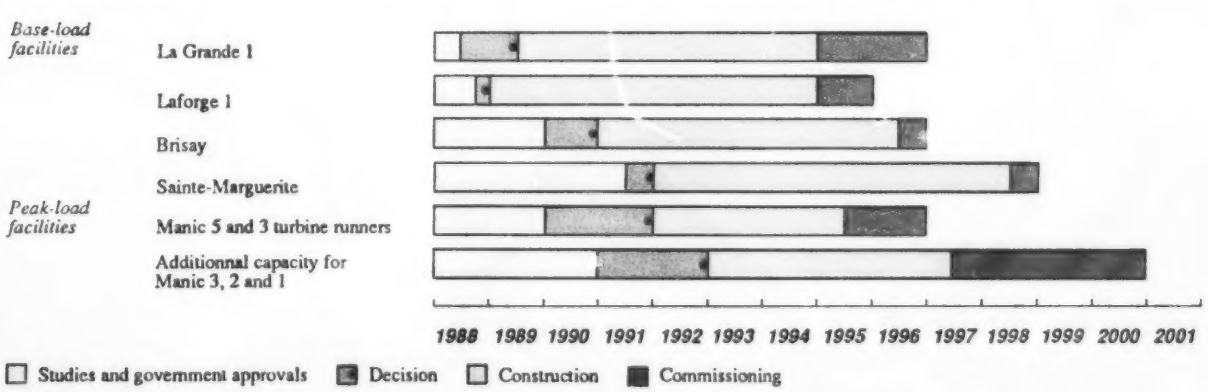
The following map shows the configuration of the future system, including the interconnection points between the production sites and load centres. First, a line will be built to transmit the power generated at La Grande Complex-Phase II to Montréal. The next line will link the North Shore with Québec City. The following table shows the sequence of these projects.

FUTURE GENERATING STATIONS

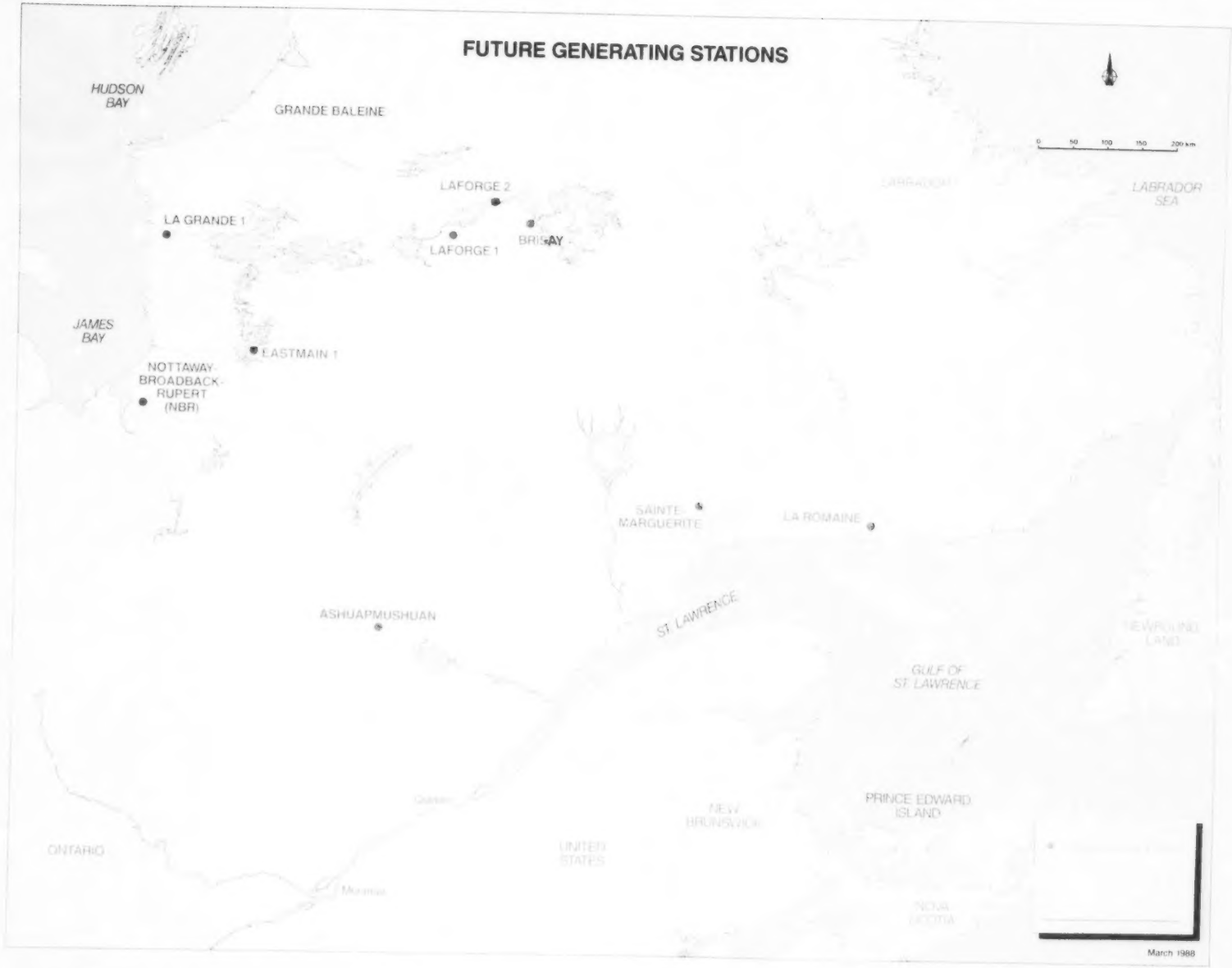
Generating station	Peak capacity (megawatts)	Commissioning*
La Grande Complex-Phase II		
. La Grande 1	1,296	1995-1996
. Laforge 1	783	1995
. Brisay	385	1996
North Shore		
. Turbine runners at Manic 5 and 3	248	1995
. Additional capacity at Manic 3, 2, 1	1,042	1997-2000
. Sainte-Marguerite	822	1998
Grande Baleine 1, 2, 3	2,891	1999-2001
Ashuapmushuan	550	2002-2003
Northwestern Québec		
. Laforge 2	270	2003
. Eastmain 1	510	2004
. Nottaway-Broadback-Rupert Complex	8,700	2004-...
La Romaine	1,710	After 2006

* According to target scenario in *Hydro-Québec Development Plan 1988-1990, Horizon 1997.*

DECISION TIMETABLE – GENERATING STATIONS IN TARGET SCENARIO



Future Generating Stations

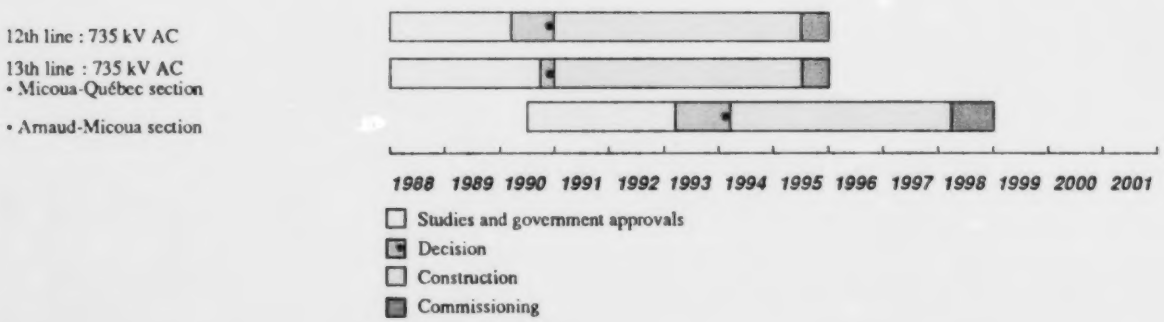


PLANNED TRANSMISSION LINES

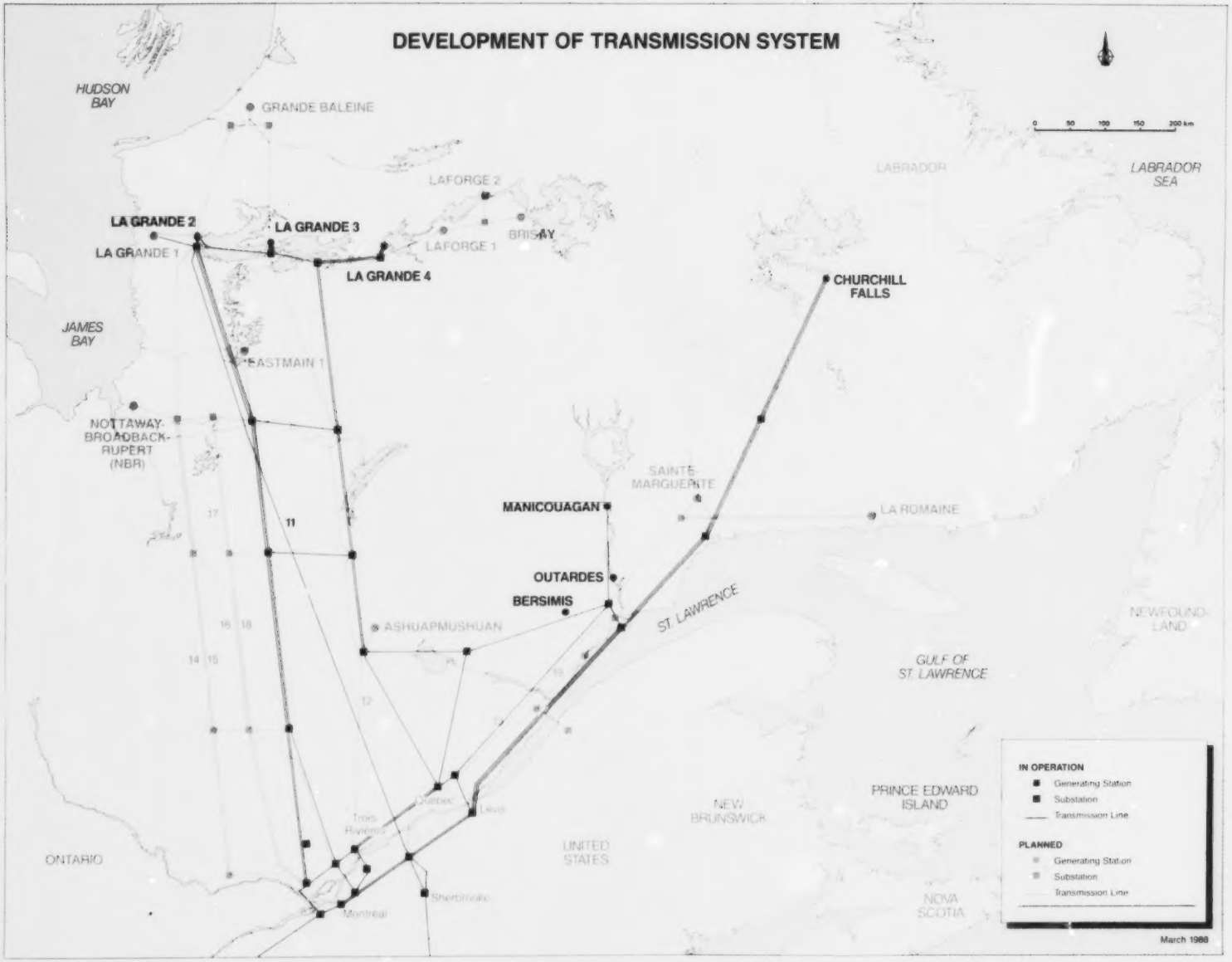
Line*	Link			Commissioning
12th line	La Grande Complex – Phase II	< – – >	Montréal	1995**
13th line	Micoua section	< – – >	Québec City	1995**
	Arnaud section	< – – >	Micoua	1998**
14th line	Grande Baleine Complex	< – – >	Montréal	1999**
15th line	NBR Complex	< – – >	Montréal	2004**
16th line	NBR Complex	< – – >	Montréal	After 2006
17th line	NBR Complex	< – – >	Montréal	After 2006
18th line	NBR Complex	< – – >	Montréal	After 2006
19th line	La Romaine Complex	< – – >	Rivière-du-Loup	After 2006

* In addition to the 11 existing transmission lines (p.6).
** According to target scenario in *Hydro-Québec Development Plan 1988-1990, Horizon 1997.*

DECISION TIMETABLE –
TRANSMISSION LINES IN TARGET SCENARIO


12th line : 735 kV AC
13th line : 735 kV AC
• Micoua-Québec section
• Arnaud-Micoua section
1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001
Studies and government approvals
Decision
Construction
Commissioning

Development of Transmission System



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en français.

Summaries

Hydro-Québec's Future Generating
and Transmission System

Options retained in the Long-Term System Expansion Plan

The options retained for Hydro-Québec's long-term construction program are based on the technology available and the concern for finding the most economical solutions with the least negative impact on the environment.

These options are to:

- continue to develop the hydroelectric potential in Québec rather than opting for other forms of electrical generation;
- continue building the high-voltage transmission system at 735 kilovolts rather than other voltage levels;
- build overhead rather than underground transmission lines;
- pursue the studies on underwater crossings in order to make the best possible choices for crossing bodies of water;
- reschedule the construction program in order to export electricity;
- improve system reliability.

The first series of summaries in this document will explain the rationale behind each of these choices.

Environmental concerns

Some environmental effects of hydroelectric generation and transmission over long distances are of concern. Hydro-Québec realizes this and actively participates, often as the industry's initiator, in studies aimed at increasing our understanding of these effects and eliminating their consequences.

The second series of summaries briefly describes six major environmental issues and the stand adopted by Hydro-Québec on each:

- the health effects of electrical installations
- mercury in reservoirs
- polychlorinated biphenyls (PCBs)
- herbicides
- the effects of electrical phenomena
- cumulative effects on the environment.

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Opting for Hydroelectricity

Hydro-Québec's Future Generating
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Because our water resources are renewable, economical and clean, they will remain the cornerstone of electrical generation in Québec.

Québec has no oil or gas reserves, but it does have 16% of the world's fresh water. Its rivers, with their significant drops in level and flows abundantly supplied by run-off, are generally well suited to the construction of generating stations and dams. In addition, the location of these waterways and the terrain surrounding them are favorable to the creation of reservoirs.

Because this renewable potential is available in great quantity and is more economical than any other form of electrical generation, Québec can count on hydroelectric power for a long time to come. Thanks to this resource, Hydro-Québec is able to offer its Québec customers a reliable supply of power at competitive rates with increases that are gradual and predictable, even for large loads.

Hydroelectric generating stations often require a greater capital outlay than other forms of generation, but this cost is financed and depreciated in the long term. Another major economic advantage is related to the operating costs for hydroelectric stations, which are very low compared with the cost of fuelling and operating a thermal power station.

The technology for hydroelectric generation has been well mastered and its environmental impact, while certainly of some concern, is generally recognized as being less harmful or risky than that of any other existing form of mass electrical generation.

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Optimum Voltage Level: 735 Kilovolts

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and Transmission System

To transmit electricity from the production sites in northern Québec to the load centres, 735-kilovolt lines fit in best with the system configuration. They are also the most economical and make use of proven technology.

The choice of voltage level for a transmission system is dictated by various factors. Above all, it is important to minimize costs and ensure reliability while limiting environmental impact.

The higher the voltage level of a line, the more electricity it can transmit and the smaller the losses. From this viewpoint, Hydro-Québec could have planned its system at 1,100 kilovolts; in fact, this possibility was studied during the planning of the transmission system in Northwestern Québec. The studies showed that this voltage level would have required fewer lines but would have cost much more than a 735-kilovolt system.

It was thus estimated that the 18,000 megawatts of potential could be transmitted using five 1,100-kilovolt lines rather than eight 735-kilovolt lines, but at an additional cost of $2 billion (1988 dollars). For this reason, the lower voltage level was chosen. In terms of environmental impact, the two options were more or less similar: on the one hand, fewer lines would have been built but, on the other hand, the electric fields would have been stronger, the rights-of-way wider and the towers larger.

The size of the towers could have been reduced by choosing an even lower voltage level. However, at 315 kilovolts, two or three times as many lines would have been needed. In addition, the towers could not have been much smaller since each would have had to support two circuits. This solution would therefore have been much more costly, without providing any real benefits in terms of environmental impact.

The system expansion could also have been planned around extra-high-voltage direct-current lines. However, this solution would not have been environmentally advantageous, since it probably would have required the same number of lines, while the high cost of converter stations would have made it less economical.

SOME TECHNICAL CONSIDERATIONS

When planning transmission facilities, certain technical factors, especially those affecting reliability, must be taken into account.

For example:

A 735-kilovolt line transmits about 2,000 megawatts of power. To limit the consequences of local hazards such as freezing rain or tornadoes, and to reduce the risk of a general power failure, no more than two lines are built in the same corridor.

To facilitate line operation and minimize the risk of jeopardizing system stability if a section of a line is lost, switching stations are built approximately every 300 kilometres. This has been found to be the optimum distance. If the sections were longer, more facilities and possibly more lines would have to be built.

The ties between corridors (switching stations) must be relatively short (about 50 kilometres) to ensure proper distribution of electricity among the corridors during normal operation, and especially if a line section is lost.

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An Overhead Transmission System

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An overhead system is the only viable solution for transmitting electricity over long distances.

People living in communities where Hydro-Québec plans to install transmission lines often ask why the lines cannot be buried. As a matter of fact, Hydro-Québec sometimes does bury its conductors along short distances for outgoing lines from power stations or for lines supplying substations in urban areas.

The higher cost of underground transmission is acceptable over short distances but over long distances it becomes prohibitive. If the electricity generated at James Bay had to be transmitted by underground cable, the project would not have been economically viable.

Even over short distances the use of underground cables is limited by technical constraints, mainly related to the insulation. All conductors, whether overhead or underground, must be insulated so as not to come into contact with other electrically conducting elements. An overhead line is insulated by the air around it, whereas, in the case of an underground cable, the insulation is provided by a jacket around the conductor. If there is a sudden overvoltage, this jacket may be perforated and the cable permanently damaged. The cable must then be replaced, which means interrupting service for a considerable length of time. These technical problems become even more serious at higher voltage levels; in fact, the highest voltages used in any of the underground and underwater cables in service today are 500 kilovolts alternating current and 300 kilovolts direct current.

Although underground cables are used more frequently for distribution at voltages of about 25 kilovolts, they are not an economical solution for extra-high-voltage transmission systems.

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Underwater vs Overhead Crossings

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and Transmission System

Hydro-Québec is continuing its development and demonstration programs on underwater HV cables in order to develop an alternative means of crossing the St. Lawrence and other waterways and to be able to make the best possible choices.

Almost half the demand for electricity in Québec is situated south of the St. Lawrence (see map on next page). Since most of the production sites are located north of the St. Lawrence, about half of the lines transmitting power to the load centres must cross the river. Underwater cables and related equipment have not yet been fully developed for voltage levels above 300 kilovolts direct current or 500 kilovolts alternating current. Until now, the St. Lawrence and other rivers have been crossed by overhead lines, because reliable technology is not available for underground or underwater cables operating at very high voltages.

Conclusive experiments or major technological breakthroughs are needed before underwater cables can be operated at 450 to 600 kilovolts direct current or 735 kilovolts alternating current. Hydro-Québec has therefore undertaken a research and development program in order to master this technology as soon as possible and to ensure that it will operate properly within the technical constraints of the system.

As part of the construction of the Radisson-Nicolet-Des Cantons line (the 11th line in the Hydro-Québec transmission system), a demonstration program is now under way to determine the feasibility of a 450-kilovolt direct-current underwater crossing. On completion of this program, Hydro-Québec will have its first extra-high-voltage underwater crossing. A temporary overhead line will be built to ensure a reliable power supply during the demonstration.

More lines across the St. Lawrence are planned for the future, most of them 735-kilovolt alternating current. Hydro-Québec is therefore conducting another development and demonstration program on 735-kilovolt cables.

The results of these programs will give the utility all the technical and economic data it needs to make the most suitable choice for future crossings.

AN UNDERWATER CROSSING TO THE MAGDALEN ISLANDS

To reduce the cost of supplying power to the Magdalen Islands, which are now supplied by diesel generators, Hydro-Québec will build a 225-kilometre underwater link to the Gaspé Peninsula using two 150-kilovolt direct-current cables. At this voltage level, it is possible to use underwater cables and related equipment that have already proven reliable elsewhere in the world.

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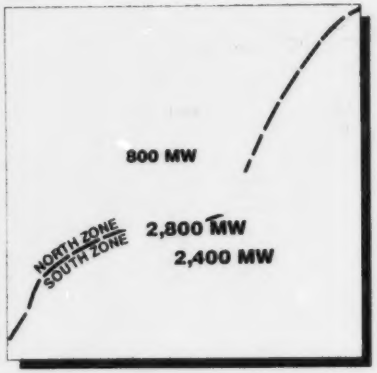
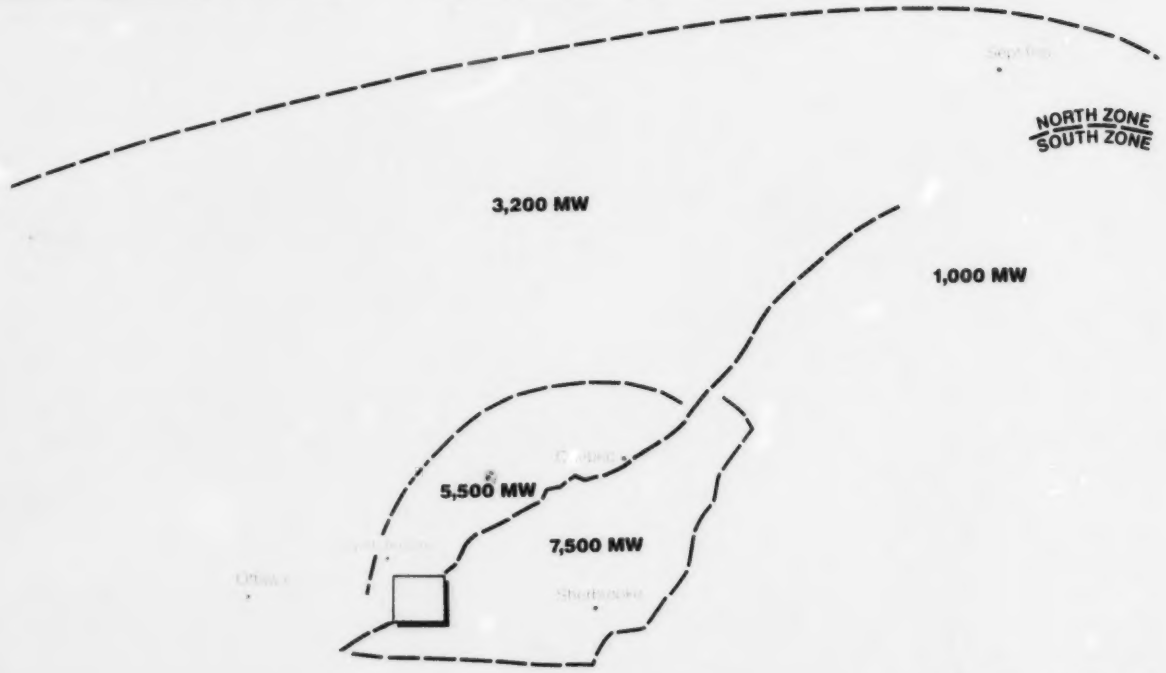
POWER DEMAND IN QUÉBEC



POWER DEMAND IN 1987 (IN MEGAWATTS)

	TOTAL LOAD	LOSSES	NET LOAD
NORTH ZONE	13,400	1,100	12,300
SOUTH ZONE	11,000	100	10,900
TOTAL FOR QUÉBEC	24,400	1,200	23,200



0 50 100 150 km

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Rescheduling for Exports

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In order to export power, Hydro-Québec plans to reschedule the construction of generating and transmission facilities which, upon expiry of the contracts, will serve the needs of Québecers.

The market constituted by neighboring systems in Canada and the U.S. (Ontario, New Brunswick, New England and the State of New York) is described in Hydro-Québec's *Development Plan 1988-1990*. These systems will face shortfalls estimated at 7,600 to 14,300 megawatts by the year 2001. This means a potential market for Québec electricity, and Hydro-Québec intends to tap into this market with an initial sales target of about 3,500 megawatts by the year 2000.

Hydro-Québec's energy potential now largely exceeds the requirements of Québec. By developing this potential sooner than required, the utility will be able to meet the demands of neighboring systems. Rescheduling will make it possible to exploit a renewable source of energy by exporting it for profit while it is not yet needed in Québec. Once the export contracts have expired and domestic markets are large enough to justify it, the generating stations and lines already built can be used to supply power to customers in Québec. The following table shows how the construction program will be rescheduled, based on a target scenario of 3,500 megawatts.

Sales to neighboring systems will be profitable and will stimulate the Québec economy by creating jobs and various spin-offs in the manufacturing and service sectors.

In addition, by developing its interconnections with neighboring systems, Hydro-Québec will be able to receive assistance from them if any of its own generating stations or lines should fail. It will also develop the possibility of multidirectional exchanges with North American systems and contribute to the optimization of system operation on both sides of the border.

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RESCHEDULING OF PROJECTS BASED ON TARGET SCENARIO IN 1988-1990 DEVELOPMENT PLAN

PROJECTS	WITHOUT EXPORTS	WITH EXPORTS
La Grande 1	1998-1999	1995-1996
Brisay	2001	1996
Laforge 1	2002	1995
Sainte-Marguerite	2003	1998
Grande Baleine	2008-2010	1999-2001
Ashuapmushuan	2013	2002-2003
Laforge 2	2014	2003
Eastmain 1	2015	2004
Nottaway-Broadback-Rupert	2016	2004

System Reliability

Hydro-Québec's Future Generating
and Transmission System

The reliability of the transmission system must be improved, not only for exports but also for Québec's requirements.

Hydro-Québec's transmission system faces a higher risk of general power failure than other systems in North America. The long lines needed to transmit power from the hydroelectric production sites to the load centres are vulnerable to electrical phenomena which can create disturbances resulting in general power failures. In neighboring systems, the production sites are closer to the load centres because generation is mostly thermal and as a result these systems are less likely to experience general power failures.

In the northeastern United States, for example, general power failures rarely occur. When they do, however, they are extremely serious, and, because generation is mostly thermal, restoration of service can take many hours or even whole days. Until 1978 general power failures in Québec were relatively frequent but much less serious, since service takes only about four hours to restore.

In the past, the utility exported its electricity from generating stations located near the border and isolated from the main grid. Consequently, neighboring systems were completely protected from failures on the main Hydro-Québec system. But today, with the growth in exports and a shortage of power stations close to the borders, exports are increasingly being made from the main grid. In this way, Hydro-Québec avoids isolating its more remote generating facilities and building transmission lines that cannot be used for Québec's own needs.

However, a general power failure on the Hydro-Québec main grid causes the simultaneous interruption of all the interconnections it supplies. Neighboring systems suddenly deprived of this additional power could be faced with a shortfall large enough to trigger a general power failure. Although Hydro-Québec has had only one general power failure since 1978, neighboring systems interested in purchasing Québec power are worried that if our interconnections were to exceed 2,200 megawatts and there was a sudden interruption, each of their systems might collapse one after the other. It should be remembered that this region had such a blackout in 1965 and, naturally, those managing the systems wish to avoid a recurrence.

For this reason, neighboring utilities are now limiting the amount of power imported from Hydro-Québec's main grid to about 2,200 megawatts. In the event of a sudden interruption in deliveries, this shortfall could be made up without jeopardizing their entire systems. The neighboring utilities are all the more concerned because the Hydro-Québec system has experienced several general power failures in the past.

Hydro-Québec wishes to supply its future interconnections from its main grid. Since the capacity of the interconnections linked to the main grid already exceeds the 2,200 megawatt limit, this constraint must be lifted. To do this, the utility must improve its system reliability and reduce the risk of a general power failure to a level acceptable to our neighbors. This can only be done if the design criteria for our system are changed.

Hydro-Québec therefore plans to invest approximately $600 million in system improvements between 1988 and 1992. In addition to generating considerable economic activity, this investment will lead to the development of external markets as well as to continued improvement of service to Québec customers. Hydro-Québec has always sought to improve the reliability of its transmission system. Since 1978 there has been only one general power failure, whereas from 1969 to 1978 there were eight. Nevertheless, each power failure entails high costs, both direct and indirect, for Québec customers, and this is why the utility intends to continue its efforts to improve its service.

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The Effects of Electrical Installations on Health

Hydro-Québec's Future Generating and Transmission System

Power lines create electric and magnetic fields around them. The possible effects of these fields on health are the subject of research in which Hydro-Québec is an active participant.

The possible effects of power lines on the health of humans and animals have been a focus of concern for more than two decades. But what do we know about it today?

We know that power lines change their natural electromagnetic surroundings. They create fields, or magnetic and electric forces around them. These fields are produced by all electrical equipment and appliances, including hair dryers, refrigerators, stereos and television sets. Their nature and intensity depend on several factors: voltage, current and type of apparatus. Field intensity decreases rapidly with distance from the source.

Today multidisciplinary teams study this phenomenon and its effects on both humans and animals, in the laboratory and in natural surroundings. The research deals with many aspects such as plant growth, growth and development in animals, physiology and behavior in animals and humans, and the possible development of certain forms of cancer.

Hydro-Québec has been very attentive to this research and has itself conducted or funded many projects. Between 1972 and 1985, it spent more than $2 million to study various aspects of its electrical installations and their possible effects on human and animal health. International bodies, especially the World Health Organization, have also studied these issues.

Most experts today agree that brief exposure to the electric and magnetic fields around power lines has no harmful effects on human or animal health. As for the long-term consequences of prolonged exposure, these still remain to be determined. However, studies are continuing and Hydro-Québec remains vigilant, ready to change its design and operating criteria should test results point to any danger to the health or well-being of its employees or the general public. In close cooperation with government bodies, it works to ensure public safety near its installations at all times.

Hydro-Québec continues to be active in research. It has allocated $7 million over a six-year period (1985-1990) to scientific studies on the biological effects of electricity.

A protocol for epidemiological studies on human health and exposure to 60-Hertz electric and magnetic fields has been approved by the Québec departments of the environment and of health and social services. This study of 150,000 employees of electrical utilities will be carried out in conjunction with Electricité de France and Ontario Hydro.

Hydro-Québec has also signed an agreement with an American utility, Bonneville Power Administration, to contribute to a study on the effects of direct-current lines on livestock.

Hydro-Québec will keep its partners and the public informed of any developments as the studies progress.

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Mercury in Reservoirs

Hydro-Québec's Future Generating
and Transmission System

The creation of reservoirs releases mercury into the water; this is a natural phenomenon which tends to decrease with time. Hydro-Québec will spend $12 million to study the phenomenon.

Several different countries have recently discovered that the creation of reservoirs releases large quantities of mercury into the water. This occurs mainly because of the decomposition of the flooded soil and vegetation.

Mercury occurs naturally in various concentrations in soil, rock, air, water and plant life. In fact, throughout the entire Canadian Shield, high concentrations of mercury have been found in the fish in rivers and lakes having no contact with reservoirs.

Nonetheless, the flooding of the reservoirs in the La Grande Complex did cause a significant increase in the mercury levels in fish -- ranging up to five times the original amount. But since the phenomenon tends to reverse itself with time, the mercury levels in fish in the James Bay reservoirs are expected to approach natural conditions within about 20 years.

Since 1982, the Cree Board of Health and Social Services of James Bay has been monitoring the mercury levels among the local Cree Indians, whose diet contains large amounts of fish.

As a result of medical examinations of the Cree population in 1987 and the monitoring of mercury levels in fish in the La Grande Complex, the restrictions on fishing areas as well as the species and quantities to be consumed have been relaxed.

The Mercury Agreement signed recently by Hydro-Québec, the Québec government and the Cree provides for more than $18 million to be spent over ten years, $12 million of which will be contributed by Hydro-Québec, as well as the formation of a committee on mercury. The research program will examine the social, cultural, economic, medical and environmental aspects of the mercury problem.

March 1988

PCBs

Hydro-Québec's Future Generating
and Transmission System

PCBs are a problem facing society as a whole -- but the problem is on its way to being resolved through the concerted efforts of users, governments and the general public.

PCBs, or polychlorinated biphenyls, are a family of 209 chemicals discovered more than a century ago and manufactured today in laboratories. They are highly stable, non-corrosive and do not burn easily, which makes them excellent insulating materials. PCBs were hailed as the answer to reducing the risk of fire in transformers and capacitors in substations and buildings, and Hydro-Québec used them.

Since 1977, PCBs have been regarded as dangerous substances: their production and sale have been prohibited in the U.S. since 1980, and ways are being sought to avoid further pollution of the environment with these substances.

If a PCB-insulated apparatus leaks, the substance will contaminate the soil and eventually be washed into the water table or nearby waterways. From there, it begins to contaminate the food chain: sediment, insects, fish, waterfowl... Thus, human beings also absorb PCBs by eating fish, for example. And at each link in the chain, the chemical builds up in the organism of the predator. As a result, the concentration is higher in a fish than in the micro-organisms it consumes.

Like the pollutants that cause acid rain, PCBs are also dispersed into the atmosphere and carried over long distances. Today they can be found everywhere, even in the Arctic.

To determine the carcinogenic potential of the substance, studies have been done on workers who had spent several years in plants where equipment containing PCBs is manufactured. No definite cause-and-effect relationship could be found. However, because of the results of some tests on laboratory animals, scientists remain doubtful of these findings and are conducting further tests.

Fire involving PCBs constitutes another danger. Depending on the temperature reached, PCBs can release highly toxic chemicals when they burn. In the event of a fire, special measures must therefore be taken, and personal safety equipment has been designed specifically for such conditions.

Hydro-Québec owns 20% of the 5 million kilograms of PCBs in Québec and shares its expertise with the other members of the PCB Users' Committee it helped form in 1985. The utility also has its own action plan for PCB management.

Hydro-Québec has developed a completely safe method of temporary PCB storage. Various decontamination and destruction techniques have been tested and others are now being studied. Through these measures, the utility hopes to eliminate PCBs from its entire system within the next eight years.

Already there are fewer PCBs in the environment than a decade ago, notably in fish in the Great Lakes. Although these substances are very stable, they eventually degrade in time.

March 1988

Herbicides

Hydro-Québec's Future Generating
and Transmission System

Hydro-Québec sometimes uses herbicides to control vegetation. It is also experimenting with the planting of shrubs that would impede the growth of trees.

To ensure system reliability, facilitate maintenance and prevent forest fires, Hydro-Québec must control the vegetation under its power lines. There are several ways of doing this: pruning branches, felling trees or spreading herbicides* from the air or from the ground. The procedure chosen varies according to the height and density of the vegetation, ease of access to the right-of-way and the type of land it crosses (urban, agricultural or forest).

For reasons of economy and worker safety, aerial spraying is used only on remote Crown lands that are difficult to reach and on rough terrain. When vegetation is to be thinned out in zones far from inhabited areas herbicides are spread from the ground. After determining the areas to be treated, Hydro-Québec establishes buffer zones which may vary from 10 to 500 metres around sensitive areas such as drinking-water supplies, farmland, waterways and inhabited areas where no spraying of chemicals is permitted. In the treated areas, Hydro-Québec regularly monitors the environmental effects of the various products and means of application used.

Hydro-Québec uses herbicides approved by Agriculture Canada that are low or very low in toxicity and would cause little impact on health and the environment.

Since 1979, the utility has been studying the migration and breakdown of herbicides in various types of soil around power lines.

Since 1983, it has been experimenting with various techniques for selective intervention throughout Québec; some but not all of these involve approved chemicals. They include spreading pellets, selective spraying, cutting and treating of stumps, individual treatment of trunks, analysis of stump-shoots during mechanical cutting, analysis of drift during land-based spraying, preparation of soil for cultivation, etc. The biological methods now being tested in the Matapédia, La Grande, Richelieu and Maisonneuve regions consist in planting low-lying vegetation (grass, crawling plants, shrubs), to prevent or curtail the growth of taller forms of plant life which would hinder system operation. In addition, an agreement with the Québec Farmers' Association, Union des producteurs agricoles (UPA), offers a solution to the problem of maintenance in wooded areas with agricultural potential: the right-of-way is prepared for cultivation by the farmer.

All these experiments are carefully monitored and their technical and economic aspects are assessed with a view to finding and optimizing methods of vegetation control for use in the 1990s.

March 1988

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* *Herbicides are chemicals designed to destroy or discourage certain forms of plant life; they are also used in agriculture and forestry.*

The Effects of Electrical Phenomena

Hydro-Québec's Future Generating
and Transmission System

Power transmission installations can create radio and telephone interference. In the event of a fault on a direct-current line, the current will return to ground, causing metal objects near the electrodes to corrode. These electrical phenomena are well understood and well controlled.

Radio interference

The waves emitted by overhead lines can disrupt radio and television signals. However, knowledge about the impact of power lines and experience in operating a complex high-voltage system have led to design criteria that keep this interference within acceptable limits. As a result, disturbances are experienced only in the immediate vicinity of the line.

In addition, when choosing routes for its new lines, Hydro-Québec respects the clearances required for telecommunications antennae, based on its own studies and those of the Canadian Association of Broadcasters in conjunction with the federal Department of Communications.

Telephone interference

To reduce problems of interference with telecommunications equipment such as telephone cables, a joint committee was formed several years ago including Hydro-Québec and the major communications companies operating in Québec. Its mandate is to inform these companies about Hydro-Québec's projects, to assess their impact on telecommunications equipment and to propose any necessary corrective measures.

Ground return current

One of the unique characteristics of a direct-current power line is its ability to continue transmitting half its capacity after one of its poles has been removed from service. This is because power lines have two electrodes installed near each end, as do most of the direct-current lines throughout the world. The current passing through the remaining pole therefore returns to ground through these electrodes.

Return to ground occurs only in the event of a fault on the line or in one of the substations, and lasts only a short time.

The possible effects of this current on underground metal objects such as pipelines and on other public-utility systems (alternating-current electrical systems, railway networks, etc.) are well known. However, they can be reduced to negligible levels if care is taken in designing and placing the electrodes.

March 1988

Cumulative Effects on the Environment

Hydro-Québec's Future Generating
and Transmission System

Hydro-Québec is undertaking a new kind of approach concerning environmental study: an assessment of the cumulative effects on the environment of its existing and future generation and transmission facilities.

Until today, environmental impact studies have been conducted case by case. But now Hydro-Québec has begun an experimental approach designed to assess the total environmental impact of its existing and future generation and transmission facilities.

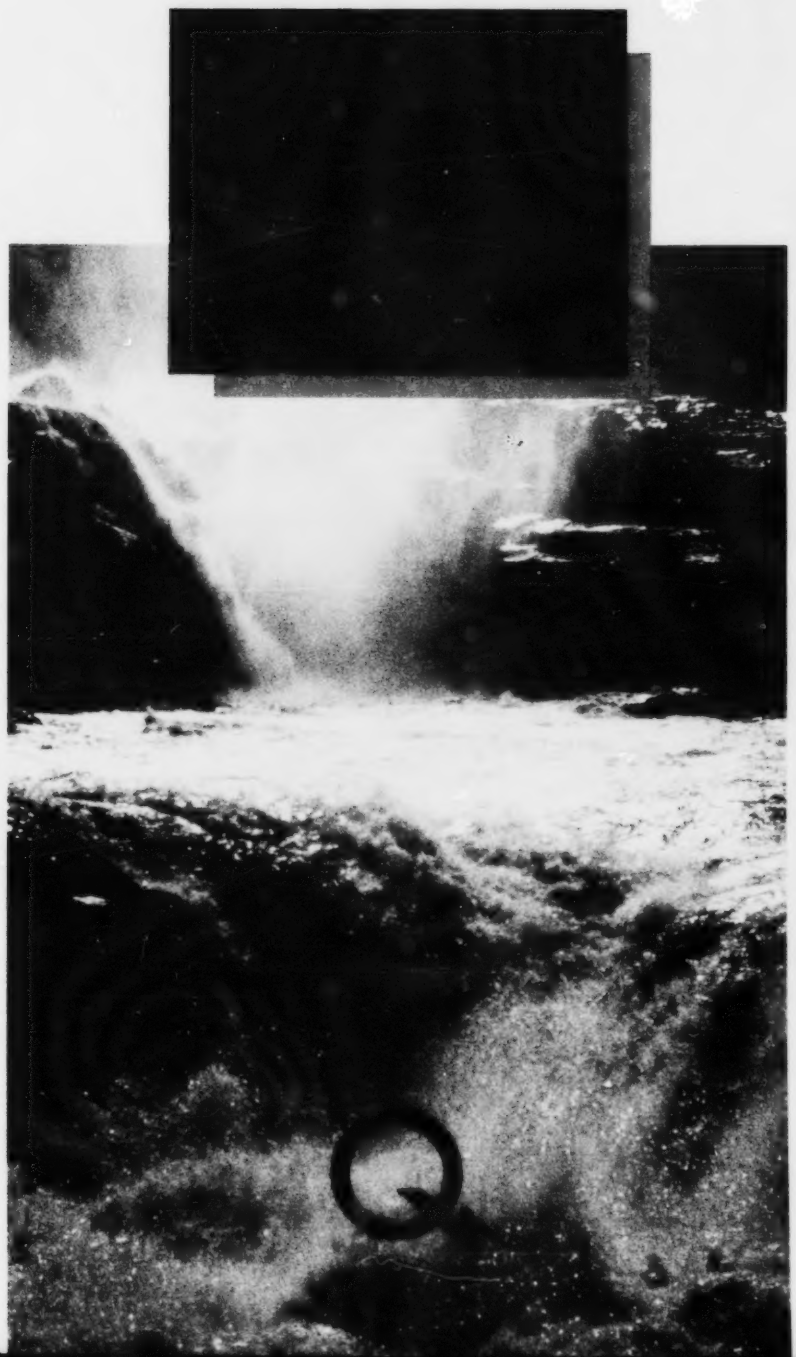
The assessment deals with the impact that its present and planned facilities will have on a given resource or territory. Hydro-Québec has undertaken a series of studies to gain better knowledge of the distribution and use of certain resources as well as the relationship between these resources and the natural environment.

The purpose of this exercise is to integrate environmental concerns with the economic and technical aspects of the construction program. If the experiment is successful, it will lead to solutions to problems related to the use of resources affected by power facilities, as well as specific corrective and development measures to offset the potential cumulative effects on the environment. It could also lead to changes in current methods of equipment planning, design and construction.

March 1988

Project Procedures and Land Use Management

Hydro-Québec's Future Generating and Transmission System



March 1988

The cover photographs show the Broadback Falls in the James Bay region and selective land-clearing along transmission-line rights-of-way to protect a white-tailed deer yard.

FOREWORD

The harnessing of the six rivers referred to in the *Long-Term System Expansion Plan* and the construction of eight lines and some 15 substations required to transmit the new output will be a major challenge for Hydro-Québec and an important source of economic activity for Québec in the coming years.

In keeping with the growing public concern for the environment in Québec, Hydro-Québec has become increasingly aware of the need to conduct exhaustive studies to ensure projects are as acceptable as possible for those affected.

Consequently, the utility intends to consult the public about alternatives being proposed for future projects in the territory and also to include in its studies any opinions the public may have regarding the construction of facilities.

This brochure is a supplement to Hydro-Québec's *Development Plan 1988-1990, Horizon 1997*. It provides information about the laws governing projects, agreements on cooperation reached with other parties, and procedures the utility applies during project execution.

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1. CONSTRUCTION PROJECTS

1.1 GENERAL FRAMEWORK

Although hydroelectricity is one of the cleanest types of energy, in order to generate and deliver it, rivers are diverted, reservoirs are created, strips of land are cleared over hundreds of kilometres and towers are erected on farmlands, in tourist areas or in towns and cities.

Over the past 15 years, the federal and provincial governments have passed laws and regulations, created agencies and established procedures to govern and control the use and development of land and resources.

Hydro-Québec must take these rules into consideration and comply with them at the planning, design and execution stages of any new project.

Northern Québec

The vast James Bay and Northern Québec region is laced with lakes, rivers and marshlands. For hundreds of years, the area has been inhabited by Cree and Inuit communities which have relied on hunting and fishing for their livelihood. The governments of Québec and Canada are the other two main parties involved in this region. Since the *James Bay and Northern Québec Agreement* was signed in 1975, the assessment and review procedure for all Hydro-Québec projects in the area is governed by very strict rules, including the stipulation that representatives of the Cree and Inuit communities and the two governments shall take part in the review and approval procedure.

Southern Québec

The land and resources in Southern Québec have been developed in many different ways as society has grown and evolved. Regulations now govern agricultural and industrial zoning, national parks, wildlife and ecological preserves and areas around historical sites as well as the development plans recently prepared by regional county municipalities. Consequently, when Hydro-Québec wishes to determine where its facilities will be built, it must take into account many different regulations and obtain authorization from a number of agencies.

It is important to appreciate that this institutional framework develops gradually along with the values of a society in evolution. Some more recent values have not yet become institutionalized. Hydro-Québec's consultations will hopefully enable the utility to integrate these different values and, what is sometimes more difficult, to balance them correctly.

In order to continue to improve its construction procedures, therefore, Hydro-Québec must be able to count on the cooperation of both its partners and all those individuals and groups affected by its projects.

1.2 LEGAL FACTORS

Major Hydro-Québec projects are subject to a rigorous and complex set of laws and regulations dealing with development and the environment.

The main laws relating to the engineering and construction of generating and transmission facilities are listed below. The first group comprises those laws under which the utility must obtain government authorization prior to construction of the project, whereas the second group includes some of the laws dealing with protected and administered resources and land.

Government authorization

- *Hydro-Québec Act*
- *Environment Quality Act*
- *Preservation of Agricultural Land Act*
- *Land Use Planning and Development Act*
- *National Energy Board Act*

Other laws

. Provincial:
- *Cultural Property Act*
- *Ecological Reserve Act*
- *Wildlife Conservation Act*
- *Parks Act*
- *Tree Protection Act*
- *Forest Act*

. Federal:
- *Navigable Waters Protection Act*
- *National Parks Act*
- *Canada Wildlife Act*
- *Fisheries Act*
- *Migratory Birds Act*

Most of these laws have given rise to a large number of regulations that govern their application and specify the requirements and the administrative procedures. In addition, many review boards and monitoring agencies have been set up under these same laws. The following tables provide some examples.

LAW	DEPARTMENT	AGENCY OR BOARD
Environment Quality Act	Ministère de l'Environnement	Conseil consultatif de l'environnement
		Bureau d'audiences publiques sur l'environnement (BAPE)
		Comité d'évaluation
		Comité d'examen
		Comité consultatif pour l'environnement de la Baie James
		Kativik Environmental Advisory Committee
		Kativik Environmental Quality Commission
Preservation of Agricultural Land Act	Ministère de l'Agriculture, des Pêcheries et de l'Alimentation	Commission de protection du territoire agricole
Land Use Planning and Development Act	Ministère des Affaires municipales	Municipalité régionale de comté (MRC)
		Commission municipale du Québec

LAW	REGULATION
Environment Quality Act	- *Regulation respecting the administration of the Environment Quality Act* - *Regulation respecting environmental impact assessment and review* - *Rules of procedure relating to the conduct of public hearings* - *Regulation respecting the environmental and social impact assessment and review procedures applicable to the territory of James Bay and Northern Québec* - *Regulation respecting certain bodies for the protection of the environment and social milieu of the territory of James Bay and Northern Québec* - *Regulation respecting pits and quarries* - *Hazardous Waste Regulation* - *Regulation respecting solid waste* - *Regulation respecting the quality of the atmosphere* - *Regulation respecting sanitary conditions in industrial or other camps* - *Regulation respecting waste water disposal systems for isolated dwellings*

All studies conducted during the design stage of a project for which government authorization has been requested are made available to the different departments and agencies depending on their respective jurisdictions, the nature of the project and the area under study. The decisions or recommendations of these departments and agencies will set the conditions for the implementation of the project. In addition, the Government of Québec must also issue a decree to formally authorize both the engineering and the construction stages of a project.

1.3 BEYOND LEGAL COMPLIANCE

Native Peoples

Hydro-Québec respects the cultural heritage and way of life of all native communities in Québec and therefore will respect the rights the federal and provincial governments acknowledge in answer to the native peoples' current demands as well as those already protected under existing laws.

The James Bay and Northern Québec Agreement

In November 1975, Hydro-Québec and the SEBJ together with the SDBJ, the Government of Québec and the Government of Canada reached an agreement with the Cree and Inuit of Québec specifying the rights and obligations of all the parties in that part of Québec north of the 49th parallel. This agreement and its amendments lay down the conditions the utility must respect when planning and building its facilities. Under the agreement, Hydro-Québec paid the native communities the sum of $176 million.

The Cree Communities

Hydro-Québec reached an agreement in November 1986 with The Cree Regional Authority, The Grand Council of the Crees of Québec and the Cree bands of Québec.

This agreement, entitled the *La Grande (1986) Agreement*, lays down the mitigation measures to be taken in connection with the construction and operation of generating stations, transmission lines and substations during the La Grande development project, Phase 2. Under this agreement, Hydro-Québec paid $112 million to the Cree communities.

The *Mercury Agreement (1986)* calls for the creation of a committee comprising representatives of The Cree Regional Authority, the Government of Québec, the Cree Board of Health and Social Services of James Bay and Hydro-Québec.

Unions des producteurs agricoles (UPA)

After two years of discussions, Hydro-Québec and UPA reached an agreement in 1986 specifying conditions relating to the design, construction and maintenance of transmission and subtransmission lines and substations in farmlands and woodlands protected by the *Preservation of Agricultural Land Act*.

The agreement defines the scope, nature and influence of the impacts of Hydro-Québec's facilities. The utility agrees to consult the UPA when it is studying the different corridors for its lines and then the individual farm owners when choosing the final route.

Provisions in the agreement call for mitigation by Hydro-Québec in the planning of routes and building of its facilities. Details on line and substation maintenance and on indemnities to be paid to landowners obliged to part with a plot of land or grant an easement are also provided

To ensure the agreement is implemented, permanent consultation procedures have been established to facilitate discussion between the parties and the eventual signing of other agreements on specific issues.

2. PROJECT PROCEDURES

2.1 HYDROELECTRIC GENERATING STATIONS

All generating station projects planned by Hydro-Québec go through three preliminary stages before detailed engineering, procurement and construction can begin. These are the preliminary study and two successive draft design phases.

The preliminary stages are carried out and the necessary government authorizations are obtained over a period of at least four years. The next phase, consisting of detailed engineering, procurement and construction, takes approximately seven years to complete.

Preliminary study

The goal of this study is to determine the best way to meet the demand forecast by Hydro-Québec. The different options are analysed, the development variants are chosen and the first economic assessments are drafted.

Environmental studies conducted at this stage provide an overview of the area to be developed. In addition, they enable the utility to identify and assess the main environmental factors which could alter the project or compel additional more detailed studies at the draft design stage.

On completion of the preliminary study, the project may be abandoned but, if the studies show that it is technically, environmenally and economically viable, Hydro-Québec will apply to the Government of Québec for authorization to proceed with the draft design. At this point, the utility informs the public about the general nature of the project and the next stages and solicits the cooperation of those concerned.

Draft design, phase 1

Hydro-Québec's objective here is to ascertain that the project is viable and to further investigate the alternative retained during the preliminary study. The technical characteristics of the project are defined and a preliminary design of the option selected is drafted, based on which the cost and schedule are estimated.

At this stage, the environmental studies serve to draw up and compare various development possibilities so that the best one can be identified and the corresponding mitigation measures recommended. These consultations help guide the utility in making its choice.

Draft design, phase 2

During the phase 2 studies, Hydro-Québec optimizes the solution chosen in order to obtain the approvals necessary to execute the project. The technical, economic and environmental aspects of the proposed design are analysed, and a detailed schedule and cost estimate are established. Environmental issues are studied in detail in an aim to specify suitable mitigation as well as surveillance and monitoring programs to be implemented during both the construction and the operating stages.

Communication during this period is aimed at informing the public as to the nature of the variances retained and guiding the utility in mitigation.

Government authorization

As the project progresses, Hydro-Québec provides the appropriate government departments and agencies with all the draft-design study results and they, in turn, authorize the utility to proceed. The table indicates the order followed.

HYDRO-QUÉBEC	DEPARTMENTS AND GOVERNMENT AGENCIES
1. – Preliminary study	
	2. – Directive issued by the Minister of the Environment – Decree authorizing draft-design studies
3. – Draft design, phase 1	
4. – Draft design, phase 2	
	5. – Public hearing and decision by the CPTAQ when applicable – Opinion on conformity from each MRC affected – Public hearing of the BAPE and decree authorizing the project with or without conditions – Decree authorizing construction and, when necessary, expropriation
6. – Execution Engineering (plans and specifications)	
	7. – Certificate from the Deputy Minister of the Environment, authorizing construction according to plans and specifications.
8. – Construction	

Construction begins once all the above steps have been taken and all the authorizations issued.

2.2 TRANSMISSION LINES AND SUBSTATIONS

As is the case for generating stations, transmission facility projects go through three preliminary stages at Hydro-Québec before detailed engineering, procurement and construction can begin. These are the preliminary study and two successive draft design phases.

The preliminary stages are carried out and the necessary government authorizations are obtained over a period of at least four years. The next phase, consisting of detailed engineering, procurement and construction, takes approximately four years to complete.

Siting of lines involves gradually limiting the land over which the line could run, going from a general study area, to a study corridor and then to a route. This process of analysis and assessment results in a variant with the least impact.

Preliminary study

The goal of this study is to determine the best way to meet Hydro-Québec's needs. The different possibilities with respect to equipment are analysed, the general location is identified, several options are advanced, an initial economic appraisal is prepared, and the optimum solution with regards to voltage load and the distances separating supply and receiving substations is determined.

Environmental studies at this stage enable the utility to identify a study area based on which it can consider all realistic and feasible siting alternatives between the generating station and the line tie-in point in light of the major environmental limitations.

Upon completion of this step, Hydro-Québec applies to the Government of Québec for authorization to proceed with the draft design. At this point, the utility informs the public about the general nature of the project and the next stages and solicits the cooperation of those concerned.

Draft design, phase 1

The goal of this first phase, which depends on the nature and scope of the projects, is normally to identify the most suitable corridor for siting the line or the best location for the substation under study.

Decisions are made only after the various technical and environmental elements in the original study area have been enumerated, the environmental impacts and the costs of the possible corridors have been analysed and compared, and the information and consultation campaign aimed at guiding the utility has been completed.

Draft design, phase 2

The phase 2 studies enable the utility to identify the route within the corridor selected or to determine the exact location of the substation. The technical, economic and environmental aspects of the project are analysed and a detailed schedule and cost estimate are established. Environmental issues are studied in detail in an aim to specify suitable mitigation as well as surveillance and monitoring programs to be implemented during both the construction and operating stages. At this stage, the variants are compared in consultation with local government representatives and other parties concerned.

Government authorizations

As the project advances, Hydro-Québec provides the appropriate government departments and agencies with all the draft-design study results and they, in turn, authorize the utility to proceed. The table indicates the order followed.

HYDRO-QUÉBEC	DEPARTMENTS AND GOVERNMENT AGENCIES
1. – Preliminary study	
	2. – Directive issued by the Minister of the Environment – Decree authorizing draft-design studies
3. – Draft design, phase 1	
4. – Draft design, phase 2	
	5. – Public hearing of the BAPE and decree authorizing the project with or without conditions – Public hearing and decision by the CPTAQ – Opinion on conformity from each MRC affected – Decree authorizing construction and, when necessary, expropriation – Certificate of public convenience and necessity issued by the National Energy Board (NEB) for the lines tied in to an American system[1]
6. – Execution Engineering (plans and specifications)	
	7. – Certificate issued by the Deputy Minister of the Environment authorizing construction according to plans and specifications. – Approval by the NEB of plans, profiles and books of reference for a line connected to an American system.
8. – Construction	

Construction begins once all the above steps have been taken and all the authorizations issued.

1 The NEB holds public hearings concerning any section of a transmission line that runs near the Canada-U.S. border and that will be connected to an American system.

2.3 COMMUNICATION WITH THE PUBLIC

Hydro-Québec's objective in analysing and incorporating public opinion in its decision-making process is to improve on its studies and make the projects as acceptable as possible to those affected.

The utility maintains ongoing communication with those responsible for administering the land and the resources at the local, regional, provincial and federal levels as well as with other parties in the area under study.

In addition, Hydro-Québec communicates with all other groups and individuals affected by the project. These include interest groups and associations, institutions, ad hoc committees formed as the project develops, landowners and other individuals particularly concerned by specific effects of the project, as well as the population at large.

Communication with the public takes place at three different stages:

- Hydro-Québec gathers information as it enumerates the social and political factors in the area affected.
- During the information campaign, all those wishing to become familiar with the project can do so.
- Lastly and above all, the population is invited to participate in the consultation sessions held by Hydro-Québec.

3. PROJECT EXECUTION

3.1 COMPENSATION

Hydro-Québec will compensate any landowners directly affected by a project for the rights and real estate it wishes to obtain in order to carry out the project. This real estate can be obtained either through an agreement reached between the utility and the owner or through expropriation. Hydro-Québec prefers to reach a negotiated settlement.

The landowner can thus grant Hydro-Québec an easement or, for substations or generating stations, an option to purchase. In exchange for the indemnity proposed, the owner must allow Hydro-Québec access to the land to install and build its facilities.

Hydro-Québec and the owner must comply with all the obligations set forth in the option and in the easement or purchase agreement. For example, the owner waives the right to erect buildings or other structures on the land subject to an easement, but the land remains the property of this owner and can be used in a variety of ways.

The fair market value of the real estate and rights to be acquired and, when applicable, the damages is appraised in advance by a qualified professional.

Should it be impossible to negotiate a settlement with the owner, under the *Hydro-Québec Act*, Hydro-Québec can obtain authorization from the Government of Québec to expropriate. The courts then determine the amount of the indemnity and the damages.

3.2 ENVIRONMENTAL MONITORING

Environmental monitoring is carried out during the engineering and construction phases.

During the engineering phase, Hydro-Québec incorporates into plans, specifications and other contractual documents respecting construction various environment-related commitments and recommendations which are included in the draft-design report and are an integral part of the conditions governing the obtaining of government authorizations. It also includes commitments the company has made during sectorial consultations.

During the construction phase, on-site monitoring makes it possible to ensure that environmental directives, standards and measures, and commitments related to the impact study, are complied with. Within six months of the completion of construction work, or according to conditions set out in an authorization certificate, a report on monitoring of the work, describing the execution of the project, is submitted to the ministère de l'Environnement du Québec.

Through environmental monitoring, Hydro-Québec is able to alter the execution of work and possibly improve procedures on the construction site, if necessary

3.3 ENVIRONMENTAL FOLLOW-UP

Environmental follow-up complements the impact study, and is a scientific undertaking designed to monitor changes in a number of environmental parameters, from the design phase to the operation of facilities. Through environmental follow-up, it is possible to verify and measure the actual impact of generating facilities in order to compare such impact with that anticipated at the time of the draft-design, and to assess the effectiveness of the mitigation and enhancement measures adopted.

This process also enables Hydro-Québec to gain greater theoretical and practical expertise and thereby not only improve its ability to foresee effects, but also to develop new forms of mitigation and possibly introduce new standards and directives.

3.4 HYDRO-QUÉBEC AND ENHANCEMENT

Once the Government of Québec has authorized the execution of a project, the representatives of local and regional communities affected are invited to propose initiatives prepared in consultation with the population as part of an environmental enhancement program.

For the preparation and execution of enhancement programs on projects whose total cost does not exceed $500 million, Hydro-Québec will allocate a maximum of 1% of the project cost for a line or substation and 2% for a generating station.

When the total cost exceeds $500 million, the enhancement program is prepared by Hydro-Québec in collaboration with local and regional authorities. These parties are responsible for determining how the program should be implemented.

Environmental enhancement is part of Hydro-Québec's environment policy. Through this policy, Hydro-Québec wishes to reestablish a certain balance among the environmental resources in an area and optimize the use of some collectively-used resources. These environment enhancement initiatives are also designed to result in economic spinoffs in the regions affected in the course of construction projects. Furthermore, they provide Hydro-Québec and the local and regional authorities with an excellent opportunity to work together.

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